SECTION III.—FORECASTS.

FORECASTS AND WARNINGS, APRIL, 1918.

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PRESSURE OVER THE PACIFIC AND ALASKA.

April is the month of highest normal pressure of the year at both Honolulu, T. H., and Midway Island. At the former place pressure during April, 1918, was continuously below the normal, while at the latter pressure was below the normal only on April 1–2, 14–16, and 19–22. At other times, especially for the 10-day period 4th–14th, pressure was markedly above the normal. There was very little synchronism between the pressure fluctuations at the two stations.

Had pressure at Midway been uniformly low as at Honolulu, it would have been justifiable to assume that the normal April HIGH over the north central Pacific Ocean for the present season would be weaker than usual; but the lack of synchronism between the two points made it hazardous to interpret the uniformly low pressures recorded at Honolulu.

In the Aleutian Islands pressure was mostly above the normal except for the period April 8–14, when there was a well-marked barometric depression that later overspread coastal and interior Alaska and the northern portions of the United States. After the middle of the month pressure was generally high both on the coast and over the interior of Alaska.

THE WEATHER IN THE UNITED STATES.

There were few abnormal features in the weather of the United States proper during April, 1918. Temperature was low for the season in the middle Rocky Mountains and Plateau region and thence eastward into the lower Ohio Valley. Rainfall was abundant in the South and there was considerable snow at the higher altitudes of the Rocky Mountain States; but the snow melted quickly.

An attempt to correlate the above conditions with the pressure distribution over the Pacific and Alaska is deferred until more observational data in the Pacific have been obtained.

In April the movement of HIGHS and LOWS begins to depart from the normal paths of the cold-weather types. The departure, in many cases, is small and not easily recognized; west of the Continental Divide, however, the change in the frequency and direction of movement of LOWS is rather well marked. The southeastward movement from the States of Washington and Oregon, characteristic of the cold season, practically ceases and there is evidence of a well-marked tendency toward the development of secondary depressions over the southern portions of Utah and Nevada as the primary depressions move eastward along the northern circuit, or fill up. The movement of these secondaries is generally erratic and difficult to anticipate; nevertheless, they exercise a marked control of the weather in Rocky Mountain States.

In April, 1918, no primary depression moved southeastward from the northern Pacific Coast States, but 5 secondaries occupied the region west of the Continental Divide and south of the 40th parallel at one time or another. East of the Rocky Mountains the LOWS were about equally distributed between the northern and the southern circuits, and but few LOWS passed from one circuit to the other. There was also, throughout the month, a distinct tendency to form secondary depressions when for any reason the progress of the primary depression was obstructed.

Extremes in the weather, due to the shifting control by cyclones and anticyclones, were specially frequent in the middle and southern Rocky Mountain States, due to the development of secondary depressions in that region in connection with the eastward and southward advance of anticyclones.

HIGHS.

The HIGHS (anticyclones), of which the paths of 9 have been plotted on Chart II, show no unusual features. Five of the 9 must be considered merely as offshoots from the principal HIGHS. On the chart the offshoots are distinguished from the principal HIGHS by a subscript letter after the number.

In general HIGHS diminished in intensity with movement to lower latitudes, but there were two cases where an increase in intensity, i. e., an increase in the central pressure, occurred as the HIGH moved eastward. An increase in the central pressure of No. *I* occurred as soon as it reached the Atlantic; No. *II* showed the greatest increase over Lake Superior; No. *IV* showed the greatest increase over the lower Lakes where its eastward progress was greatly reduced. HIGH No. *V*A, beginning as a remnant of No. *V* with an initial pressure of but 30.10 inches in western Montana, slowly increased in intensity as it moved east-southeastward, attaining a maximum pressure of 30.52 inches in Kentucky on May 3. The apparent cause of the increase in this case was a corresponding increase in the intensity of the LOW which immediately preceded it.

While the advent of a HIGH is generally equivalent to a brief spell of fair weather, the combination HIGH on the north or northeast–LOW on the south or southwest in April is generally tantamount to a spell of unseasonable weather with snow in northern districts, thundershowers and warm weather in southern districts. Cases illustrating this condition occurred on several dates during April, 1918, in the Rocky Mountains Region; also in the New England and Middle Atlantic States on the 11th, 12th, and 13th. The storm along the Atlantic coast from the Virginia Capes to Boston on those dates was practically continuous for about three days. Fresh northeasterly gales with high tides swept the coast and caused much damage to and destruction of beach property. There was also some loss to shipping at anchor in New York Harbor. The snowfall in interior districts extended as far westward as northeastern Indiana, and in Vermont the fall amounted to at least 7 inches in localities. Fortunately, there was no loss of life, although the property loss will aggregate close to $1,000,000.

The sustained high northeast winds during the storm period were due to the eastward advance of HIGH No. *II*, which seemingly prevented LOW *I*A (see Chart III) and its offshoot, *I*B, from advancing directly northeastward on the normal path. Inasmuch as the HIGH was of more than ordinary intensity the wearing-down process was a slow one. As an indication of the drift of the lower air out of the region occupied by the HIGH, it may be said that the surface wind at Washington, D. C., shifted to the northeast at 11 p. m. on April 9 and continued uninterruptedly from that direction for 40 hours; the speed of the wind when the shift occurred was 24 miles per hour,

and it continued at that rate for 24 hours, dropping to 15 miles per hour at the end of the period.

During this time there was a dense cloud layer moving in the direction of the surface wind. Precipitation in the form of rain began on the 8th and was practically continuous after 6 p. m. of that date, turning to snow during the 11th. The total amount for the four days was 3.53 inches. The suggestive thought, however, is what a tremendous amount of water vapor was carried inland over the Middle Atlantic States as evidenced by the amount collected at a single point; and, second, considering the volume of air carried bodily southwestward from the southeastern face of the HIGH as well as the loss due to condensation of water vapor, is it not remarkable that pressure in the HIGH should not sink to a lower level than it did? In that part of the HIGH where air was continually moving away from the center the reduced pressure was highest, 30.46 inches at 8 a. m. of the 10th, and it sank gradually to 29.90 inches by 8 a. m. on the 13th. Thereafter it rose as the wind shifted to the northwest.

LOWS.

The paths of 16 LOWS of greater or less intensity have been platted in Chart III. It is not easy to distinguish between the so-called primary and secondary LOWS in April. It is customary to think of practically all primary LOWS as reaching North America from the Pacific on the west, or from tropical waters on the south and southeast. For the month of April, as has already been indicated, there is a decided break in the continuity of movement. This change is undoubtedly a seasonal one and is probably a direct result of surface warming in the arid and semi-arid region of the far Southwest whereby local centers of buoyancy are initiated in the levels a kilometer or so above the surface. Because of the prevailing aridity in this region, these incipient LOWS cause little precipitation, except on the west side and in the rear with the advance of anticyclonic conditions. Because of the fact that these LOWS may remain practically stationary for several days at a time, it is difficult to anticipate their influence upon weather conditions east of the Rocky Mountains.

In this April 5 LOWS occupied the far Southwest at one time or another, and 3 other LOWS had their origin in the Rio Grande Valley. Several of these have been classed as principal LOWS, but the great majority were secondary depressions. The details of their movement can be seen from Chart III. The severe weather in New England and the Middle Atlantic States, above described, was due to the inability of LOW *Ia* to advance northeastward on April 10.

WARNINGS ISSUED.

An extensive and unusually prolonged display of storm warnings on the Atlantic coast began on April 9 with the issue of northeast warnings from Norfolk to Boston. The storm center after reaching southeastern Virginia on the morning of the 10th, seemed to be on the point of filling up, but 12 hours later what appeared to be a new storm center appeared on the South Carolina coast. This center advanced northeastward, keeping a short distance off the coast, causing moderate to fresh northeast gales from Cape Cod to the Virginia Capes. On the night of the 11th the warnings were extended from Boston to Eastport, Me. The greatest severity of the storm winds was experienced, however, along the Middle Atlantic coast as already stated.

Warnings were again displayed on the Atlantic coast on the 17th and 21st. In both cases they failed of verification.

Another display was made on the 26th from Charleston to Boston. This storm was quite severe along the Virginia and North Carolina coasts, thence it pursued a northeast course some distance offshore and gave no storm winds north of Cape Henry. On the 28th, however, heavy sea swell and increasing northeast winds were reported from Nantucket, but by that time the center was far off to sea and no further indication of its presence was received.

Storm warnings on Great Lakes.—The season for the display of storm warnings began on April 20 when a display was made on account of a disturbance over western Tennessee. The disturbance advanced over the Great Lakes, but the barometric gradient slowly decreased and the warnings were only partially verified. Warnings were again displayed on the Great Lakes on the 28th and 29th. These warnings were also only partially justified although a sharp fall of temperature with snow on Lake Superior on the 30th made navigation difficult.

Frost warnings.—Frost warnings were issued for some part of the Washington forecast district on April 5, 8, 9, 12, and 19.

WARNINGS FROM OTHER DISTRICTS.

Chicago, Ill., forecast district.—The warnings issued during April, 1918, were confined to frost warnings at intervals, and to cattle or sheep warnings on the 2d and 25th. The interests in Illinois and Missouri demanded frost warnings from the first of the month, and warnings were sent to these States on the 7th, 8th, 9th, 10th, and 12th, and they were in every case fully verified.

The area covered by frost warnings was gradually extended northward and westward, embracing by the 30th all the States in the district, except the Dakotas, Montana, and Wyoming. Warnings of freezing temperature were issued for a considerable area on the 18th and 19th, and as the minima promised to fall to exceedingly low points, advices were sent even to the Dakotas. By the morning of the 20th the temperature was down to freezing, or below, from Lake Michigan westward over the upper Mississippi Valley to and including the northern Rocky Mountains region, and reaching as far south as Kansas and northwestern Missouri on the west. The entire area was fully warned in advance.

Additional warnings were issued on the 22d for frost in Wisconsin and Nebraska and freezing temperature in Minnesota. Warnings of frost again went out on the 27th for Nebraska and Kansas, and on the 28th for those States, together with Iowa, Missouri, and Wisconsin, and warnings of freezing temperature for Minnesota. On the 30th frost warnings were again issued for Illinois, Missouri, Wisconsin, and the eastern portions of Minnesota and Iowa. As a result of the critical temperatures vegetable growth was much retarded in the area affected. It is not known what actual benefits were derived from the warnings.

The live-stock warnings issued on the 2d for Missouri, Nebraska, Kansas and southeast Wyoming and on the 25th for South Dakota, Wyoming, and Nebraska were specially for the sheep interests—it being the lambing and shearing seasons—as the temperatures were not low enough to affect larger live stock. It is believed that these warnings were of much value, as strong northerly winds with freezing temperature and some snow followed.—*H. J. Cox, District Forecaster.*

New Orleans, La., forecast district.—Frost warnings were issued during April, 1918, as follows: For Oklahoma and northern Arkansas, April 7; Arkansas, April 9; the greater portion of the district, April 10; eastern

portion of Louisiana and Arkansas, April 11; Texas Panhandle and northwestern Oklahoma, April 16; Oklahoma and the northern portion of west Texas, April 17; Oklahoma, northern portion of western Texas and the extreme northwestern portion of eastern Texas, April 19; over the northern portion of the district, April 20; Oklahoma, Arkansas, and the interior of Louisiana, April 21; Oklahoma and northwestern Arkansas, April 28; Oklahoma and northwestern Arkansas, April 30. The warnings were generally justified.

Small-craft warnings were issued for the western Gulf Coast on April 6. Storm winds occurred locally on a few dates on the Texas coast, but there was no general storm without warnings.—*I. M. Cline, District Forecaster.*

REPORT ON SPECIAL WARNINGS ISSUED IN THE DENVER DISTRICT.

Denver, Colo., forecast district.—Unsettled weather predominated in the Denver district during April, 1918; there were few days without a low-pressure area somewhere in the district. Of the sixty 12-hour periods in the month, temperatures were below the seasonal average 25 periods in Colorado and 16 periods in half of Colorado. In Utah, 17 periods were colder than the seasonal average and 10 in half of that State. In New Mexico the duration of the warm and cold periods was about equally divided, while in Arizona there was a slight preponderance in the duration of the warm periods.

On the morning of the 2d low pressure prevailed in southern districts, the axis of the depression extending from Nevada eastward to Missouri, while high pressure prevailed from the Pacific northwest to the Lakes region. Live-stock warnings were issued for eastern Colorado and northern Utah. During the next 24 hours the front of the anticyclone moved southward east of the Continental Divide, attended by freezing weather, with snow in northeastern Colorado and snow flurries and sleeting weather in parts of southeastern Colorado. While temperatures in Utah and eastern Colorado remained low for several days, no damage of consequence to fruit interests resulted, owing to the backward condition of orchards. The benefits derived from the snowfall more than offset any damage that occurred. On the evening of the 13th a deep low-pressure area was central in southern Nevada, with isobars of the depression extending northward to Alberta, while relatively high pressure prevailed along the Pacific. Live-stock warnings were issued for northern and western Utah. Rain fell in northern Utah the following night, attended by a decided fall in temperature.

Forecasts of freezing temperatures were included in the daily forecasts on 16 dates for parts of Colorado, Utah, and New Mexico, and practically all were fully verified. General distributions of these warnings were unnecessary, owing to the backward condition of fruits and gardens.—*Frederick H. Brandenburg, District Forecaster.*

San Francisco (Cal.), forecast district.—During April, 1918, rainfall in this district was deficient and the temperatures averaged above normal. There were several severe frosts in northern California during the first few days, and frosts occurred frequently in the northern Pacific States throughout the month. Practically no rain fell during the last 15 days, and the need of it for crops was beginning to be felt in the north and becoming urgent in the south at the close of the month.

Small-craft warnings were ordered on the morning of the 8th at northern Pacific seaports, and on the 14th along the southern coast of California.

Storm warnings were ordered on the 8th at 11:10 a. m. along the northern California coast, and extended that evening to include all northern Pacific stations. This warning was fully verified in California and partially verified in the northern Pacific States. On the 13th a steep barometric gradient developed between the mouth of the Columbia River and Sitka, Alaska; and consequently southwest storm warnings were ordered at 6:30 p. m. at the entrances to the Strait of Juan de Fuca and the Gulf of Georgia, and also at the mouth of the Columbia River. No high winds occurred during the following night and the warnings were taken down early the next morning.

Frost warnings were issued for one or more places in the northern Pacific States on 16 days, and on 8 days in northern California. Nearly all of these warnings were verified, and no damaging frosts formed without ample warnings having been sent to the places where the frosts occurred.

Live-stock warnings were sent to places in eastern Oregon, southern Idaho, and Nevada on the 2d; to eastern Oregon, eastern Washington, Idaho, Nevada, and the northern half of California on the 12th; and to southeastern Washington, eastern Oregon, Idaho, and Nevada on the 24th. All of the live-stock warnings were verified, and the following telegram was received from the Antelope Valley Land & Cattle Co. on the 13th, in acknowledgment of the warning sent that company on the 12th:

TOPAZ, CAL., *April 12, 1918.*

MR. BEALS,
United States Weather Bureau,
Merchants Exchange Building, San Francisco, Cal.

Have notified owners representing over 100,000 new-born lambs contents your telegram. All feel very grateful and wish expression of thanks conveyed to you. This company intended to commence shearing to-morrow, but will defer until after the storm. High, cold southwest wind blowing here now. Many thanks.

ANTELOPE VALLEY LAND & CATTLE CO. 10:35 p. m.

Two weather and temperature forecasts, one on the 2d and the other on the 18th, failed of justification. The first affected the eastern and southern portions of northern California. It was expected that a LOW over Utah on the evening of the 1st, which had remained nearly stationary during the following 12 hours, would continue stationary long enough to cause showers where predicted; but although it remained stationary for 24 hours and caused good rains in Nevada and showers in southern California, none was reported at stations within the northern California area where rain had been predicted.

The other forecast was made on the morning of the 18th, when showers and cooler weather were predicted for the second period of the forecast in the northern portion of northern California, western Oregon and western Washington. The mistake was made of misjudging the extent of the HIGH over the ocean. It was thought the LOW over western British Columbia and the relative low pressure over California would form a trough-shaped depression within the next 24 hours, that would extend from California northward over western Oregon and western Washington into British Columbia. Within this trough of low pressure cloudiness was expected to increase and be followed by showers, and the cloudiness and showers would have caused lower temperatures. Instead, the HIGH moved northward causing northerly winds and clear weather during the period, and the forecast was a failure.—*E. A. Beals, District Forecaster.*